

**Statement of Brian Richter  
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The Nature Conservancy  
Before the Committee on Transportation and Infrastructure  
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Mr. Chairman and members of the Committee, thank you for the opportunity to testify on the impacts of climate change on water resources. I am Brian Richter, the Director of the Global Freshwater Initiative for The Nature Conservancy. My comments today will focus on three areas:

- streamflow alteration,
- flood management, and
- ecosystem impacts and adaptation.

The Nature Conservancy is an international, nonprofit organization dedicated to the conservation of biological diversity. Our mission is to preserve the plants, animals and natural communities that represent the diversity of life on Earth by protecting the lands and waters they need to survive. Our on-the-ground conservation work is carried out in all 50 states and in more than 30 countries and is supported by approximately one million individual members. The Nature Conservancy has protected more than 117 million acres of land and 5,000 miles of river around the world. Our work also includes more than 100 marine conservation projects in 21 countries and 22 U.S. states.

The Conservancy owns and manages approximately 1,400 preserves throughout the United States—the largest private system of nature sanctuaries in the world. We recognize, however, that our mission cannot be achieved by core protected areas alone. Therefore, our projects increasingly seek to accommodate compatible human uses, and, especially in the developing world, to address sustained human well-being

Water flowing through natural freshwater ecosystems sustains fisheries, wildlife habitat, recreational opportunities, tourism and many other cultural values. Healthy aquatic systems also provide ecosystem services by absorbing pollutants, recharging ground water, decomposing waste, and generating and distributing nutrients that nourish complex food webs, which extend well beyond river channels and lakebeds to floodplains and estuaries. Properly functioning rivers, lakes and wetlands are the very foundation upon which virtually all living things on earth depend. Failure to protect freshwater ecosystems has tangible societal, cultural and economic consequences.

Climate change is perhaps the greatest long-term threat to the healthy aquatic ecosystems that support people, plants and animals. Prompt action to address this threat is critical to minimize future harm to nature and to the social and economic fabric of our communities. We can already see the effects of a changed climate, including increases in global average air and ocean temperatures, increased precipitation in some areas and more frequent and severe droughts in

others, and an increase in the occurrence of intense weather events. These impacts are here today, and they are projected to continue and, in many cases, intensify in the future.

While the testimony provided today will focus on adaptation strategies in order to avert the most extreme effects, strong action to address the causes of climate change is essential. The Nature Conservancy is calling for legislation and policies that include three paramount concepts:

- A strong cost-effective cap on emissions and a well-designed market-based program designed to stabilize atmospheric greenhouse gas concentrations at a level that ensures the well-being of human communities and ecosystems worldwide. As a member of the U.S. Climate Action Partnership, the Conservancy endorses the coalition's call for specific U.S. emissions reductions to achieve the goal of limiting global atmospheric greenhouse gas concentrations to a level that minimizes large-scale adverse climate change impacts to human populations and the natural environment.<sup>1</sup>
- Reduction of emissions from forest and land-use practices through the incorporation of verified credits from these practices in a cap-and-trade program.
- Support for adaptation programs designed to help ecosystems and the human communities that rely on them to cope with the impacts of climate change.

The principles outlined here recognize that strong measures are needed now to reduce the sources of greenhouse gases that contribute to global climate change, but significant effort is also required to mitigate projected impacts. Uncertainties in future human responses and the persistence of previously emitted gases mean that even with reductions in greenhouse gas emissions, we will continue to feel the effects of climate change for decades to come. It is important for organizations, agencies and individuals to identify strategies and policies to help human communities and ecosystems adapt to a changing climate.

### **Streamflow Alteration**

Freshwater and estuarine plants and wildlife have evolved in concert with and are sustained by the natural variations in water flow that occur seasonally, annually and over the course of many years. The natural, seasonal patterns of rising and falling water levels in lakes, rivers, wetlands and estuaries shape aquatic and riparian habitats, provide cues for migration and spawning, distribute seeds and foster their growth, and enable these highly productive natural systems to function properly. Altering the natural flow pattern takes a serious toll on the plants and animals that depend on it.

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<sup>1</sup> The US CAP's Call to Action states

“We recommend Congress establish a mandatory emission reduction pathway with specific targets that are: between 100–105% of today's levels within five years of rapid enactment; between 90–100% of today's levels within ten years of rapid enactment; between 70–90% of today's levels within fifteen years of rapid enactment. The short- and mid-term targets selected by Congress should be aimed at making it clear to the millions of actors in our economy and to other nations that we are committed to a pathway that will slow, stop and reverse the growth of U.S. emissions. Furthermore, Congress should specify an emission target zone aimed at reducing emissions by 60% to 80% from current levels by 2050.”

The Call to Action and more information on US CAP is available at [www.us-cap.org](http://www.us-cap.org).

Nearly all of our nation's rivers and streams already have unnaturally altered flows due to dams, diversions, channelization and land-use changes. Human impacts such as pollution and unsustainable fishing practices further stress these aquatic ecosystems. Many of these ecosystems have been so altered by human influences that their ability for natural adaptation and response to stress has been compromised. The anticipated changes in climate are predicted to happen at an unprecedented rate, further challenging any natural adaptation capacity. For these reasons, aquatic ecosystems are particularly vulnerable to climate change, which will exacerbate the stresses already induced by other human related activities.

In light of these issues, it is important that policy and on-the-ground adaptation approaches recognize the need to maintain healthy and resilient ecosystems that will preserve their ability to adapt to climate change and to continue to provide for both human and wildlife needs.

### *Climate Change Impacts*

Streamflow patterns rise and fall seasonally with changes in precipitation, evaporation and snowmelt. Flow increases in the spring as snow melts and declines with the higher temperatures of summer. Global climate change will profoundly affect these natural streamflow patterns even more than humans have already altered flow directly. Increases in runoff and earlier spring discharge are expected in many glacial and snow-fed rivers, while higher summer temperatures will increase evaporation and evapotranspiration, in turn leading to reduced/lower summer flows.<sup>2</sup>

Regions across the United States will be affected by these changes in differing ways. Alaska anticipates increased flooding, especially in ecologically critical coastal wetlands. Pacific coastal and Rocky Mountain states expect earlier spring peak runoff, more winter flooding and less summer streamflow. Southwestern states are bracing for lower base flows due to reduced groundwater recharge and for increased flash flooding. Midwestern states may expect more severe droughts and possible steep declines in summer streamflow. The Great Lakes are likely to recede due to reduced tributary streamflow. Northeastern states may contend with large reductions in streamflow and changes in the magnitude and timing of spring floods. Southeastern and Mid-Atlantic states may have lower base flows, larger peak flows and longer droughts. Every region anticipates higher water temperatures, which weaken the ability of freshwater plants and animals to tolerate the other changes.<sup>3</sup> And every region is faced with uncertainty regarding the magnitude and timing of climate change impacts.

These changes in streamflow will also severely impair our ability to meet human water needs. Already, competition for limited water resources between irrigators, municipalities, industrial users and hydropower generators has ignited untold conflict in this country. Even water-rich eastern states are mired in "water wars" that we usually associate with the water-strapped western region. Georgia, Alabama and Florida, for example, have involved no less than twelve federal agencies in attempting to resolve long-standing disputes over water allocation in the

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<sup>2</sup> Intergovernmental Panel on Climate Change, Contribution of Working Group II to the Fourth Assessment Report, Summary for Policy Makers, 2007.

<sup>3</sup> [http://www.isse.ucar.edu/water\\_climate/html\\_map.html](http://www.isse.ucar.edu/water_climate/html_map.html) (Specific sources for each prediction are fully cited here.)

Apalachicola-Chattahoochee-Flint and Alabama-Coosa-Tallapoosa river basins. Climate-change induced reductions in water supplies during critical seasons will only exacerbate the competition for water nationwide.

It is the government's role to ensure that reduced water supplies are allocated to meet demands justly and efficiently. But it is critical that providing for these competing demands in the face of climate change does not come at the expense of our natural aquatic systems. The key to providing for all demands efficiently is flexibility to adapt in the face of uncertainty. Water-supply systems that are flexible to respond to both short- and long-term changes in streamflow patterns have built-in resiliency to floods, droughts and rising temperatures. And resiliency secures water supplies both for direct human demands and for the healthy aquatic ecosystems that support them.

### ***Comprehensive Water Resource Management***

*Environmental flows* are the amount and timing of water flows required to maintain the components, functions, and resilience of freshwater ecosystems. A well-managed water resource is allocated to people and to environmental flows according to the needs of both.

Fortunately, proven approaches for comprehensively managing water resources for humans and nature already exist. But in the vast majority of the country, water managers still lack the basic knowledge of when and where water is physically and legally available in the basins they manage. Despite the availability of sophisticated water accounting systems, very few are actually applied to real-world regional water management in the United States.

In this respect, Texas leads the nation with its Water Availability Modeling (WAM) system. WAM, which was implemented in 1997 by the Texas Commission on Environmental Quality in collaboration with water users and managers, computes water availability and reliability at 13,000 stream sites within 20 watersheds covering 685,000 square kilometers. By systematically accounting for the cumulative effects of all natural and engineered controls on streamflow, including diversions, return flows and reservoir storage, WAM enables competing demands on each stream segment to be managed efficiently, taking into account both upstream and downstream flow requirements. Through WAM, the state incorporates environmental flow requirements into each new water permit, thus integrating ecological resiliency into statewide water management. Although the state does not currently consider climate change in its permitting decisions, WAM is a flexible tool with the proven capability of modeling the impacts of climate change on water availability.<sup>4</sup>

**Recommendation:** The ability to manage water comprehensively over entire basins is fundamental to ensuring flexibility in the overall system and is particularly important in the wake of a changing climate. To adapt, it is necessary that all areas of the country adopt and implement comprehensive approaches to water accounting and management.

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<sup>4</sup> Wurbs, Ralph A., Ranjan S. Muttiah, and Fabrice Felden. 2005. Incorporation of climate change in water availability modeling. *Journal of Hydrologic Engineering* 10 (5):375-385; Wurbs RA. 2005. Texas water availability modeling system. *Journal of Water Resources Planning and Management* 131(4):270-279.

## ***Demand Management***

Equally critical to adaptive, resilient water resource systems is to have water-demand management plans in place for times of drought. Even in water-scarce western states, innovative drought management has successfully averted ecological disaster without threatening senior water rights. The **Big Hole basin in Montana** is one such stirring example. After nearly a decade of chronic water shortages and ensuing conflicts, state and federal agencies, working together with local stakeholders, have implemented rules for voluntary cutbacks in irrigation diversions and sport fishing, triggered by measured drops in streamflow. Meanwhile, applied hydrologic research has targeted irrigation efficiency measures to specific stream reaches where they most benefit the rest of the basin. Finally, The Nature Conservancy and others are working to improve degraded stream habitat to enable water to move more freely downstream, helping to maintain cool temperatures and good water quality in the otherwise drought-stressed river.

Thus, after years of distrust and debate among ranchers and agencies over irrigation water use, compounded by the threat of federal listing of the imperiled Arctic Grayling fish as an endangered species and water rights laws that discourage water conservation, the tables are starting to turn. Working together, the people in the Big Hole basin have shown that strategically reducing consumption during periods of drought and restoring stream habitat increases the resiliency of the river and of both the human livelihoods and native species that depend on it.

**Recommendation:** As changes in climate increase the likelihood of drought conditions in parts of the country, states and localities should develop demand management plans that enable water users to reduce consumption during periods of drought. Federal funding and policy should support these efforts.

## ***Sustainable Water Storage***

Historically, society's response to floods and droughts has been to impound surface water in reservoirs, and to release it as needed. However, a dearth of geologically suitable locations for new dams, a decrease in the reliability of water available to fill dams, and an increased awareness of their ecological consequences, will hinder this response to future hydrologic extremes, even as their frequency and intensity increase. In many areas, an integrated solution can be achieved by managing ground water and surface water together. By artificially recharging excess runoff, depleted aquifers can be transformed into underground "reservoirs" to supplement the flood- and drought-buffering capacity of existing surface-water reservoirs. Existing infrastructure such as irrigation systems can be used to distribute water and recharge aquifers.

Another way to increase storage without building new reservoirs is to increase the capacity of existing dams and manage the stored water in environmentally sensitive ways. Increasing storage behind hydropower dams increases renewable energy production but decreases the capacity for flood control. Floods that are allowed to return to their natural floodplains recharge underlying aquifers, which slowly release groundwater back to the river as cool, steady baseflows. By directing some of the new revenues generated by the additional power production toward floodplain restoration and flood mitigation below the dam, both aquatic ecosystems and electricity consumers benefit. The additional water retained behind existing dams can be released

during exceptionally dry periods, buffering the downstream ecosystem's ability to withstand drought.

**Recommendation:** Storing water is an important strategy for increasing resilience of both human and natural systems to floods and droughts. Great capacity exists for increasing storage and improving its management within existing infrastructure rather than constructing and maintaining new reservoirs.

### ***Streamflow Restoration***

Sometimes, increasing resiliency to climate change means removing infrastructure. Everglades National Park in Florida is removing canals and levees that block natural water movement in order to restore the Everglades' capacity to capture and store water. The restored streamflow will recharge aquifers, creating a freshwater barrier to the landward push of rising saltwater as well as maintaining supplies for human use.

Specifically allocating water for instream flow is a prudent way to hedge against future water demands by ensuring that a sufficient amount of water is not allocated to a consumptive use and remains available for future water shortages. However, most states lack effective legal mechanisms for protecting instream flow allocations from downstream depletion. Although water allocation is administered by the states, the U.S. Environmental Protection Agency and the Army Corps of Engineers, through their federal authority to protect water quality and restore aquatic ecosystems, have the responsibility to protect streamflow for ecological health.

The Army Corps of Engineers has a critical role to play in allocating water for instream flows. The operating procedures for the hundreds of dams that the Corps owns and operates still largely reflect the twentieth-century priorities of providing inexpensive water, power and flood control to encourage settlement and economic growth. The Sustainable Rivers Project, an innovative partnership between the Corps and the Conservancy, has already demonstrated at several sites that dam re-operation to increase instream flow allocations benefits downstream ecosystems while only minimally affecting traditional dam functions.<sup>5</sup> Updating operating instructions by specifically incorporating flow releases that benefit the river ecosystem at the nearly two thousand dams under federal control could do a great deal to improve river health and increase resiliency to climate change.

### **Flood Management**

#### ***Climate Change Impacts***

Climate change will bring significant implications for flood management, requiring greater attention to preparation and adaptation. Both inland and coastal flooding are expected to increase with climate change. An increase in heavy precipitation events combined with a greater level runoff from glacial and snow-fed rivers will cause more inland flooding in some areas across the

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<sup>5</sup> Postel S, Richter B. 2003. *Rivers for Life: Managing Water for People and Nature*. Washington, D.C.: Island Press, p. 92-102

country.<sup>6</sup> Sea-level rise and amplified storm intensity will cause more frequent coastal flooding as well.

Higher floodwaters will cause damage to life and property; and more silt and pollution in rivers. Flooding will also dislodge stored organic carbon (an important food source for many species);<sup>7</sup> reduce breeding habitat for amphibians, migratory shorebirds and waterfowl; and increase erosion.

The Intergovernmental Panel on Climate Change reports that climate change will likely mean more intense hurricanes with higher wind speeds and heavier precipitation. In fact, evidence has shown an increase in storm intensity since about 1970, which has been correlated with higher sea surface temperatures.<sup>8</sup> Coastal flooding and erosion will be exacerbated by more intense storms.

It is important that our responses to this challenge consider the role healthy ecosystems can play in mitigating the impacts of these projected changes in flood regimes. For example, coastal wetlands provide natural buffering capacity for the impacts of storm surges and coastal flooding. Similarly, healthy and functioning floodplains provide greater levels of storage and flood capacity during flood events. As a result, the design of flood protection projects should account for the role of healthy ecosystems and seek to implement a mixture of hard and soft infrastructure instead of purely structural approaches to meet flood control needs.

### ***Non-structural Approaches***

A prime example of how such an approach can be implemented is the **Hamilton City Flood Damage Reduction and Ecosystem Restoration project**. Hamilton City is located on the Sacramento River, which is the largest river in California, draining approximately 24,000 square miles and supplying 80 percent of the freshwater flowing into the Sacramento-San Joaquin Delta. Historically, the river was lined by 800,000 acres of riparian habitat. More than 95 percent of this habitat has been lost. The remaining mosaic of riparian and aquatic habitats along the Sacramento River is home to several listed threatened and endangered species, including neotropical migrant birds, all four runs of chinook salmon and steelhead trout.

Hamilton City and surrounding agricultural lands are only marginally protected from flooding by a degraded private levee (circa 1904) called the “J” Levee. The “J” Levee does not meet any formal engineering standards and provides only a 66 percent chance of passing a 10-year flood. As a result, Hamilton City has mounted flood fights and has been evacuated due to flooding six times in the last 20 years, a situation that could be exacerbated with the impacts of climate change.

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<sup>6</sup> Intergovernmental Panel on Climate Change, Contribution of Working Group II to the Fourth Assessment Report, Summary for Policy Makers, 2007.

<sup>7</sup> Poff, N. L., M. Brinson, and J. B. Day. 2002. Freshwater and coastal ecosystems and global climate change: a review of projected impacts for the United States. Pew Center on Global Climate Change, Arlington, VA.

<sup>8</sup> Intergovernmental Panel on Climate Change, Contribution of Working Group I to the Fourth Assessment Report, Summary Report for Policy Makers, 2007

For over 25 years, the community attempted—unsuccessfully—to secure federal engagement in their efforts to reduce the risk of flooding to the town and the surrounding agricultural lands that are critical to the town's economy. It was not until habitat restoration was incorporated into the project that the benefit of the project was deemed sufficient to justify the cost. Project partners collaborated to conduct a feasibility study, which produced a plan with broad bipartisan support. The plan involves construction of a new set-back levee and reconnection of about 1,500 acres of floodplain to the river, which will simultaneously facilitate restoration of riparian habitat and significantly enhance flood protection for the community. This dual purpose project has the potential to be a true "win-win"—by meeting the flood-control needs of the local community and providing greater flood storage capacity in the watershed while restoring riparian habitats and natural river processes.

**Recommendation:** As we attempt to address greater levels of flooding expected with climate change, we must develop projects such as this setback levee project that recognize the services that ecosystems provide and build these services into the project design. As the primary federal agency responsible for flood management projects, the Army Corps of Engineers should build upon existing projects such as the Hamilton City project and expand planning and design approaches to incorporate the role of ecosystems into flood mitigation efforts.

### ***Reconnection of Floodplains***

The ability of many ecosystems to provide ecological services such as flood protection has been degraded. Often, floodplains are disconnected from the river by levees and other development, resulting in the loss of an ecosystem's natural ability to store flood waters and reduce the intensity of floods. As flood events increase in frequency and intensity, it will be important to restore the natural capacity of riverine systems to store flood waters.

Floodplain reconnection is one of the most significant aquatic ecosystem restoration needs for the health of an array of aquatic species. As a result, we must make ecosystem restoration and floodplain reconnection a top funding priority. Moreover, policies should be implemented to discourage development of floodplains and to encourage protection of these resources.

The benefits of floodplain restoration are illustrated by the Conservancy's work at **Spunky Bottoms in Illinois**. In the relatively few years since the Conservancy began work at Spunky Bottoms, the landscape has been transformed. Once drained and used for farmland, this land now is a thriving wetland landscape that gets richer in plant and animal life every year.

Restoration at the preserve has included the re-establishment of wetlands and open-water habitats by reducing the amount of water being pumped out of the area. The Conservancy has planted 110 acres of upland prairie and more than 6,500 hardwood trees. The replanted species are thriving, as are other wetland plant species that have re-emerged from a seedbank that survived during the decades that the preserve was farmed. Waterfowl are returning to the preserve in impressive numbers—peaks of more than 16,000 ducks and geese have been documented since restoration began.



The Conservancy now is working with the Army Corps of Engineers to reconnect Spunky Bottoms with the Illinois River. Because river reconnection projects are so rare, the work at Spunky Bottoms provides an important model for similar projects within the Upper Mississippi River system and beyond. A managed connection with the river will provide access for migratory aquatic species, including paddlefish and gar, while mitigating the degradation of the preserve's backwater areas from excessive sedimentation, unnatural water level fluctuations and exotic invasive species. In addition to the immense ecological benefits, reconnection of rivers can serve as a mechanism to reduce the intensity of flood events. Such ecosystem restoration projects provide an alternative to increased investment in levees and other structural approaches.

**Recommendation:** National policy should fund and create other incentives for approaches such as floodplain reconnection that help human and natural communities adapt to climate change by maintaining and restoring healthy ecosystems. To ensure the ability of natural systems to provide flood reduction benefits, there should also be strong disincentives for new development in floodplains.

### ***Planning Tools***

To ensure that water resource projects and land management decisions consider projected impacts of climate change and incorporate ecosystems into decision making, it is important to have planning tools that value the role of ecosystems. The Conservancy is working with partners to develop tools that allow decision makers to use ecosystem-based management to make development decisions with the goal of maintaining an ecosystem in a healthy, productive and resilient condition so that it can provide the services humans want and need. Such an approach is critical if we are going to preserve ecosystems while continuing to provide for human needs in the wake of climate change.

These tools will provide information to decision-makers that helps them better address multiple objectives, such as projected climate impacts, flood protection and wetland restoration. The Conservancy conducted a case study that examined approaches for jointly meeting objectives in biodiversity conservation and coastal hazard mitigation on the Gulf Coast in Florida, which is an area with abundant and diverse wetlands and an area where the hazards from tropical storms and hurricanes have significant impacts on human communities and biodiversity.

In this study, spatial data representing risk and vulnerability to coastal hazards was overlain with information on coastal wetlands that could mitigate some of these hazards. The analysis identified areas to target conservation efforts that would meet both biodiversity and coastal hazard mitigation objectives. Only a small fraction of the total wetlands in the Panhandle (less than 20 percent) are identified in this analysis, which places a priority on a particular set of wetlands that are important for meeting both hazard mitigation and biodiversity objectives. As hurricane intensity is likely to increase and coastal systems are changing due to sea-level rise and other climate-induced impacts, this case illustrates an approach that incorporates multiple objectives into decision-making processes.

More information on this tool can be found at [www.marineebm.org](http://www.marineebm.org)

## **Ecosystem Impacts and Adaptation**

In addition to the effects discussed above, climate change will also cause a rise in water temperatures. Water temperature plays a crucial role in the health of river and stream ecosystems and is one of the factors of stream ecology that influences the overall health of the ecosystem. For example, the distribution of species and growth rates of aquatic organisms are determined, in part, by water temperature. Stream temperatures are projected to rise 0.9° C for each 1° C rise in air temperature.<sup>9</sup> In some places, water temperatures have already reached the lethal limits for some fish species. A recent analysis projects that thermally suitable habitat for 57 species of cool- and cold-water fish will decline by 50 percent in U.S. rivers if air temperatures rise by 4° C.<sup>10</sup> As water temperatures rise, the survival of many aquatic species may depend on their ability to migrate upstream to cooler waters. Access to suitable migration corridors is necessary for this movement to succeed.<sup>11</sup> Several states in the Northeast are actively removing old, unused dams that block fish migration. Allowing these fish to migrate to higher elevations and latitudes as temperatures increase may be the key to their surviving climate change.

Increases in water temperature will also have perverse effects on coastal ecosystems, affecting all vital processes including activity, feeding, growth and reproduction of aquatic organisms. Coastal marine systems such as coastal waters, bays and estuaries, and adjacent shorelands such as beaches, dunes and barrier islands are also susceptible to sea-level rise, which will increase the depth of coastal waters. Sea-level rise will also allow salinity to intrude deeper into estuaries, threatening the species that inhabit them. Shorelands are most susceptible to sea-level rise, which will inundate lowlands, erode beaches and increase flooding. Saltwater wetlands may also drown if sea levels rise faster than the wetlands are able to build themselves up.

### ***The Nature Conservancy's Climate Monitoring and Adaptation Work***

In order to better understand these changes and how wildlife and ecosystems may adapt, scientists at the Conservancy are actively monitoring these and other climate change impacts around the world. With a growing understanding of present and future scenarios, the Conservancy will be better equipped to help ecosystems cope with warming, changes in precipitation and other impacts of climate change. The following are examples of such projects:

- In the **Albemarle Sound of North Carolina**, the Conservancy is developing restoration projects that would help protect the shoreline from increased erosion and inundation caused by rising sea levels. In the Albemarle Peninsula, drainage ditches originally dug to drain farmland now channel salt water inland. This inflow is harming native vegetation and threatening natural diversity. Intrusion is further compounded by high tides and

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<sup>9</sup> Schindler, D.W. 1997. Widespread effects of climate warming on freshwater ecosystems in North America. *Hydrol Proc.*

<sup>10</sup> Poff, N. L., M. Brinson, and J. B. Day. 2002. Freshwater and coastal ecosystems and global climate change: a review of projected impacts for the United States. Pew Center on Global Climate Change, Arlington, VA.

<sup>11</sup> Poff, N. L., M. Brinson, and J. B. Day. 2002. Freshwater and coastal ecosystems and global climate change: a review of projected impacts for the United States. Pew Center on Global Climate Change, Arlington, VA.

storm surges. The Conservancy is working to restore the Peninsula, preparing it for sea-level rise through a variety of efforts such as working with landowners to convert lands to forests, installing floodgates to prevent salt water intrusion, removing hard armoring along the coast, and working with the U.S. Fish and Wildlife Service to incorporate additional adaptation measures in their management plan. The Conservancy is also planting native cypress forests, restoring submerged aquatic vegetation beds, establishing reefs to block storm surges, and planting brackish marsh grasses on shore lands that are likely to be submerged. This work is now being applied to other vulnerable coastal areas along the United States eastern coast and into Central America.

- In **New Mexico**, the Conservancy is conducting a statewide analysis to identify places, species, systems and other natural resources threatened by climate change. The study will also propose measures that land and water managers can take to abate threats to plants, animals and ecosystems.

Climate change will alter landscapes, rivers, streams and seascapes as we know them. Projects such as those listed above will help us analyze the impacts of climate change on plants, animals and natural communities. These projects will also help to create innovative conservation solutions that will enable natural areas to cope with and adapt to what may be the unavoidable effects of climate change.

**Recommendation:** The Nature Conservancy believes that comprehensive climate legislation should include support for adaptation programs that are designed to help ecosystems and the human communities that rely on them to cope with the impacts of climate change. This should include investment to provide detailed and geographically specific information about the impacts of climate change on specific ecosystems and use of such research to guide ecosystem restoration and management activities. Lastly, while investment in adaptation measures is critical, this work does not abrogate the need for addressing the root causes of climate change; reducing greenhouse gas emissions now can avert the most extreme impacts.

## **Conclusion**

The impacts of climate change on aquatic ecosystems will be profound. Hydrologic flow will be altered, incidents of flooding and droughts will increase, water temperature and sea levels will rise, and hurricane intensity will increase. Failing to protect freshwater and coastal ecosystems from these changes will have tangible societal, cultural and economic consequences. Our response to climate change must recognize the role that healthy ecosystems can play in mitigating these impacts to both humans and natural communities. It is important that all of our policy and on-the-ground adaptation approaches recognize the need to maintain healthy and resilient ecosystems that preserve the ability to adapt in the face of climate change and continue to meet the needs of both humans and wildlife.

In order to enable aquatic ecosystems to provide for human and wildlife needs in the face of a changing climate we must:

- Design water-supply systems that are flexible to both short- and long-term changes in streamflow patterns including increased floods, droughts and rising temperatures.

Specifically, states and localities should develop demand-management plans that enable water users to reduce consumption during periods of drought. Federal funding and policies should support these efforts.

- Allow ecosystems the flexibility to adapt to the changes in streamflow by providing water allocation in a manner that meets both human and ecosystem needs. This includes allocating water to instream uses to hedge against future water demands.
- Adopt comprehensive basin-wide approaches to water accounting and management to preserve the flexibility of the water system to adapt to change.
- Utilize a mixture of hard and soft infrastructure, e.g. setback levees, to protect communities from increased flooding associated with climate change and expand planning and design approaches to incorporate the role of ecosystems into flood mitigation efforts.
- Craft national policy that funds and creates incentives for approaches such as floodplain reconnection that help human and natural communities adapt to climate change by maintaining and restoring healthy ecosystems.
- Invest in applied research on the impacts of climate change on specific ecosystems and provide dedicated funding for ecosystem adaptation efforts.

While critical, these adaptation measures do not lessen the need to address the causes of climate change. As outlined above, measures to reduce greenhouse gas emissions are necessary to avert the most extreme impacts of climate change and must go hand in hand with any adaptation strategies.

Thank you again for this opportunity to testify.